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Application No.	S970741
Date of Filing	13 October, 1997
Applicant	VISERGE LIMITED, an Irish company of Unit 28, IDA Centre, Pearse Street, Dublin 2, Ireland.

Dated this 10, day of May, 2000.

CERTIFIED COPY OF PRIORITY DOCUMENT

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S97074

FORM NO. 1

REQUEST FOR THE GRANT OF A PATENT

PATENTS ACT 1992

The Applicant(s) named herein hereby request(s)
[ ] the grant of a patent under Part II of the Act
[X] the grant of a short-term patent under Part III of the Act
on the basis of the information furnished hereunder.

1. Applicant(s)

VISERGE LIMITED
Unit 28, IDA Centre, Pearse Street, Dublin 2, Ireland.
an Irish company

2. Title of Invention
A remote terminal unit

3. Declaration of Priority on basis of previously filed application(s) for same invention (Sections 25 & 26)

Previous Filing Date	Country in or for which filed	Filing No.

4. Identification of Inventor(s)

Name(s) and addresse(s) of person(s) believed by the Applicant(s) to be the inventor(s)
Graham O'Donnell
5 Lower Albert Road, Sandycove, Dun Laoghaire, Co. Dublin, Ireland.
Morgan Sheehy
55 Nutley Avenue, Dublin 4, Ireland.
Adrian Kearney
24 roselawn road, Castleknock, Dublin 15, Ireland.

5. Statement of right to be granted a patent (Section 17(2) (b))

The applicant derive the right to file by virtue of a Deed of Assignment dated October 10, 1997.

6. Items accompanying this Request

(i) [X] prescribed filing fee (IRP 55)
(ii) [ ] specification containing a description and claims
[X] specification containing a description only
[X] Drawings referred to in description or claims
(iii) [ ] An abstract
(iv) [ ] Copy of previous application(s) whose priority is claimed
(v) [ ] Translation of previous application whose priority is claimed
(vi) [X] Authorisation of Agent (this may be given at 8 below if this Request is signed by the Applicant(s))

7. Divisional Application(s)
The following information is applicable to the present application which is made under Section 24 -

Earlier Application No.
Filing Date:

8. Agent

The following is authorised to act as agent in all proceedings connected with the obtaining of a patent to which this request relates and in relation to any patent granted -

Name & Address

Cruickshank & Co. at their address recorded for the time being in the Register of Patent Agents is hereby appointed Agents and address for service, presently 1 Holles Street, Dublin 2.

9. Address for service (if different from that at 8)

Signed Cruickshank & Co.
By: C. Schutt Executive.
Agents for the Applicant

Date October 13, 1997.

 APPLICATION ... S97074

"A Remote Terminal Unit"

The invention relates to a remote terminal unit and more particularly to a design methodology and architecture for such units.

For the purposes of this specification reference is made to the use of a remote terminal unit according to the invention used in the distribution of electrical power however it will be readily apparent to those skilled in the art that the invention may equally be applied in a wide variety of applications. For example the unit may equally be used for the monitoring and control of oil, gas, water, telecommunications, transportation or chemical utilities.

Transmission of electrical power by utility companies is achieved in a number of stages. Each stage requiring careful monitoring and control to ensure the adequate availability and continuance of fault free supply. To provide the monitoring and control functions required remote terminal units (RTUs) are used. These units are located at many points across the power distribution network allowing a central computer system to manage the operation of the network with minimal resources. The RTUs are programmed to monitor the status of inputs connected to the distant plant and drive outputs to remotely control the plant devices such as high voltage switches and communicate with the central system.

Power utilities face a wide variety of problems in distributing the necessary power particularly given the daily increasing demands for the delivery of such power. In developing economies for example it is currently estimated that an additional generating capacity of three billion megawatt hours will be required over the next five

to ten years. In addition to this utility companies are also under increasing commercial pressure to reduce costs and improve efficiency. In order to address this problem modern information technology is being widely used however this technology infrastructure rapidly becomes obsolete and therefore must be regularly updated to maintain quality of service despite increased demand with obvious cost implications.

A further problem for the distribution of this power relates to the distribution network itself. As the networks have evolved and expanded over long periods legacy of plant are common and represent much of the capital infrastructure of the network. Many of these units are immensely costly and it is therefore often essential that the new transmission and distribution networks built to respond to increased demands operate in an integral manner with these legacy units which vary enormously in age and structure. This is particulary important in that cost controls dictate that every effort is made to extend the life of these capital assets for as long as possible.

There is therefore a need for an improved remote terminal unit RTU which will overcome these problems.

Accordingly there is provided a remote terminal unit comprising at least one cell, each cell having a processor and communication means for communication with other remote terminal units.

Ideally the communication means is formed for inter-operation with associated cells of the same unit.

In one arrangement each cell comprises:-

a microprocessor for processing plant information;

a data storage device for storing operational instructions relating to the function of the cell;

a communications interface for linking the cell to a master control unit of the controlled network;

an operating system for controlling operation of the microprocessor and interpreting instructions from the memory device;

diagnostic utilities for validating operation of the cell and adjacent cells;

a database for storing information relating to functional operation of said adjacent cells;

an inter-cell communication means for directing movement of information between cells;

a power supply; and

a plant interface for receiving status information from a plant item and returning control information from the cell to the plant item.

Ideally the inter-cell communication means incorporates re-configuration means for updating the data storage device of a connected cell to change the function of the connected cell. Preferably the plant interface is expandable to control a variable number of plant items.

For the purposes of this specification the term cell is taken to mean the smallest re-configurable operating component of the remote terminal unit.

The invention will be more clearly understood from the following description of a number of embodiments thereof given by way of example only with reference to the accompanying drawings in which:

Figs. 1a, 1b and 1c are block diagrams of known remote terminal unit architectures;

Figs. 2a and 2b illustrate diagrammatically a single cell and a number of associated cells respectively for use in the invention;

Fig 3 is a diagrammatic view of a remote terminal unit comprising a number of cells formed in accordance with the invention;

Fig 4 is a detailed diagrammatic view of a remote terminal unit similar to Fig. 3 comprising a number of cells formed in accordance with the invention; and

Fig 5 is further detailed diagrammatic view of a remote terminal unit similar to Figs. 3 and 4 illustrating inherent inter-cell communication redundancy.

Referring to the drawings and initially to Figs. 1a to 1c there are illustrated a number of known remote terminal unit architectures. Each of these architectures includes the use of a controlling microprocessor to control overall operation of the remote terminal unit. Figs. 1b and 1c illustrate the use of sub-processors under the control of the controlling processor to augment the main processor and perform functions such as input/output to plant. The inclusion of these sub-processors is a relatively recent

development and has become feasible only because the cost of microprocessors has declined.

While providing the advantage of reduced installation costs using sub-processors, due to distributed capability over cabling to a central location their reliance on the control processor represents a fundamental architectural weakness. This is particularly apparent in complex applications where performance bottle-necks are common. While processors have become more powerful so too has the complexity of the task and units of the type illustrated are prone to failure caused by a single component. Even units not currently suffering from performance bottlenecks are likely to do so in the future as a result of increased supply demand.

Furthermore, the functions which these units can perform are inflexible and frequently such units are proprietary and cannot communicate with units from other vendors. As each component of this type of RTU is different, being manufactured as a separate element and configured for a given purpose there are few opportunities to reduce cost through the use of identical components. Additionally, due to the rigid structure it is not possible for RTU suppliers to provide an evolutionary path for Utilities over any reasonable period. While elements such as the main microprocessor can be upgraded the interconnection scheme which links it to sub-processors is frequently age dependent. Linked to this are difficulties associated with using these units, as the main microprocessor has to understand the relationships and interactions between it and its sub-processors information must be frequently configured to be directed from one process or to another and applications may be such that they are designed to run only in specific locations.

The known architectures are limited in the scale of applications which may be addressed. For example utility companies frequently operate very small substations comprising no more than a few pieces of equipment in the same area as large substations having several thousand pieces of equipment distributed over an area of thousands of square metres. While each of these facilities require the performance of similar functions and it is clearly desirable for the Utility to be able to use the same technology for both. Current solutions are either not cost effective or are technologically undesirable.

In order not to unnecessarily obscure the present invention specific references to performance characteristic, I/O devices, memories, processors, circuit and timing diagrams, have been omitted as it will be readily apparent that the invention may be implemented using any number of known technologies. This is particularly so given that the specific implementation will depend on the application to which the invention is applied and the environment in which it will operate.

Referring now to Figs. 2 to 5 there are illustrated a number of embodiment of the current invention outlined as a cell illustrated generally by the reference numeral 1. Each cell 1 has a processor module and a number of input/output modules the combination of both modules forming a single cell. Each cell 1 represents the smallest operating unit of the remote terminal unit and may in very small applications be the remote terminal unit. Generally the processor module and I/O module comprise a microprocessor, data storage, communications interfaces, an operating system, diagnostic utilities, indications, a database, inter-cell communications, a power supply and a plant interface. For larger

applications a number of inter-operable cells are joined to provide the required functionality.

Within the cell 1, a wide variety of I/O modules may be used with the processor module allowing each cell to be optimised for the plant with which it is interfacing. The cell 1 also contains two or more serial ports for communications purposes connected to the processor module.

As indicated cells may be "stand alone" for small numbers of I/O points and for larger systems, cells may be networked together as the I/O count demands. Each processor module in response to application demands can have two network interfaces to guard against the failure of one (See Fig. 5).

Plant indications from the monitored network for example such as breaker status are received by the processor module and stored in a RAM device. The processor module then retrieves the data values and formats them into a protocol which it then transmits using the microprocessor or responds to a poll from a master station. Master stations of this type are typically located in a control centre which would poll each RTU looking for data and the processor module determines from data stored in the RAM device the most appropriate data to return.

Whenever a plant item changes state and causes one of the inputs to the I/O module of a particular cell to change, the change is detected by the cell 1 and the processor module broadcasts across the network. In the same way as the processor determines the most appropriate response to a poll from the master station other cells receive the transmission relating to the change information and can process if necessary.

A most important feature of the current invention is the replacement of a controlling processor with a number of processors each assigned an appropriate task or group of tasks within the overall operation of the RTU. The number of processors and thus the number of cells is determined by the complexity of the control task. Each cell, containing essentially identical component elements is interchangeable and differentiated form adjacent cells only by an instruction set associated with each processor module which may be re-configured remotely.

For example, a particular processor may be nominated as a communications processor and have a communications protocol installed in it. It will examine the changes arriving over the inter-cell network and those that are required by the protocol will be accepted, formatted and transmitted out in response to a poll from a master station.

Protocol firmware is installed in a number of cells such that if one cell fails all the others remain operational and communications within the network is maintained. It will be appreciated that the particular protocol used is not important to the operation of the invention, nor is the function assigned to any given cell. Functions may be duplicated across cells to guard against the failure of any one cell and as indicated duplication of I/O connections between to two cells can be configured such that if one cell fails the I/O is still monitored by the other cell. Additionally as each cell has a unique power supply failure of the power supply in one cell does not affect other systems. Because of the I/O inter-connection between cells and the non-dedicated nature of any given cell the RTU operation may be altered by changing the mode of operation of any cell using any other cell. Thus, it

is possible to configure the entire system (consisting of many cells) from one cell either by plugging a configuration device directly into the serial port on that cell or by down-loading configuration over the communications protocol. In addition, because each cell is not dependent on a central or controlling processor and has its function assigned locally it is possible to provide cells which can be configured to perform tasks not normally associated with the network by down-loading appropriate function instruction to the processor module of the cell.

As cells share common characteristics, which makes it possible for any collection of them to be used in any configuration for a given application without prior knowledge or design expertise development and installation costs are significantly reduced. A critical consideration for the operation of the invention where multiple cells are used is that for a group of intelligent cells to operate as one they must have an intimate and accurate knowledge of one another's operation even though they are in fact individual entities this is achieved using the inter cell communication of each cell.

The most important features of the invention relates to the fundamental characteristic that there is no principal or controlling cell which co-ordinates the activities of other cells and similarly, no cell has priority over other cells. Any cell may be configured to perform any function and functions are not pre-defined but are assigned by simple software allocation. In addition to the flexibility that this approach offers work can be distributed evenly throughout the structure and the system is immune to total failure.

As system performance demands increase it is imperative that new cells may be added or individual cells upgraded, without effecting operation of adjacent cells. It can also be seen that new cells incorporate requisite additional resources and thus place no additional burden on existing cells and applications. In this way true scalability is achieved.

The cells communicate with one another over dual redundant high speed LANs (local area networks) which is essential to provide the level of availability required in utility applications. Based on a common medium cells communicate with one another and perform functions either individually or collectively. Aspects of the invention which are redundant in order to provide the highest possible availability and integrity include - power feeds, communications interfaces, communications highways, operating system and applications. Additionally, functions can be isolated so that there are no adverse interactions due to human or technological error. In sensitive applications it is extremely important that total system failure cannot be caused for minor reasons.

In this way it will be appreciated that the invention provide an RTU which has no single point of failure in which integrity is of a much higher order than can be achieved with traditional approaches. Additionally down-time for any collection of cells is such that availability is exceptionally high as the communication organisation and inter-cell operational monitoring is such that errors or failures are immediately reported.

Similarly, as any cell can perform any function and as many cells as required can be deployed the unit is ultimately flexible. This is particularly so given that there are virtually no limitations on expansion as large

numbers of cells can be added and new cells with later technology can be added to old cells thereby overcoming the problem of technological ageing. As the cells are very similar their components can be mass produced resulting in significant cost savings and reduction in implementation lead times and user training.

The invention may be implemented using a wide variety of strategies which will be readily apparent and accordingly is not limited to the embodiment hereinbefore described but may be varied in both construction and detail.

CRUICKSHANK & CO.

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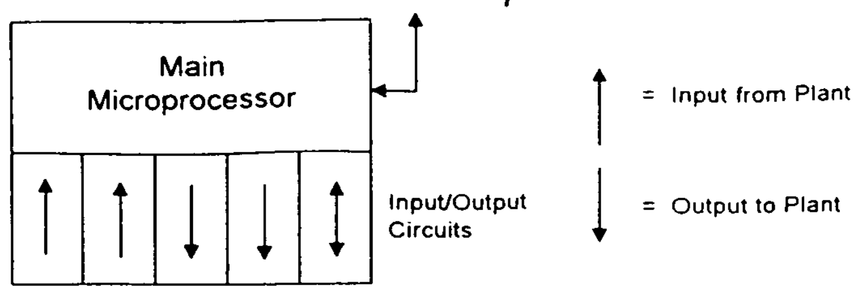


Fig. 1a

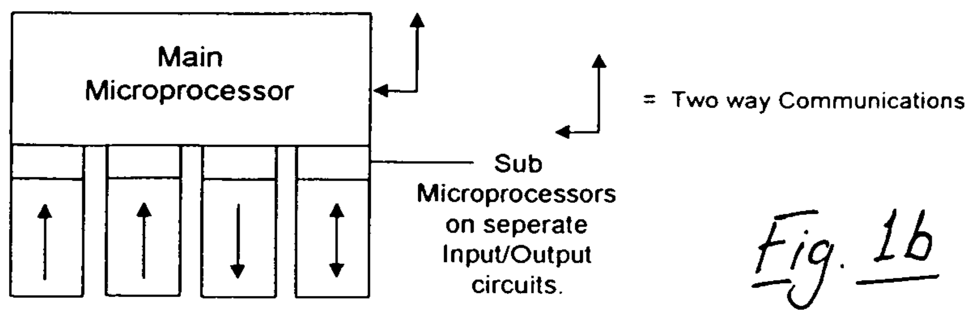


Fig. 1b

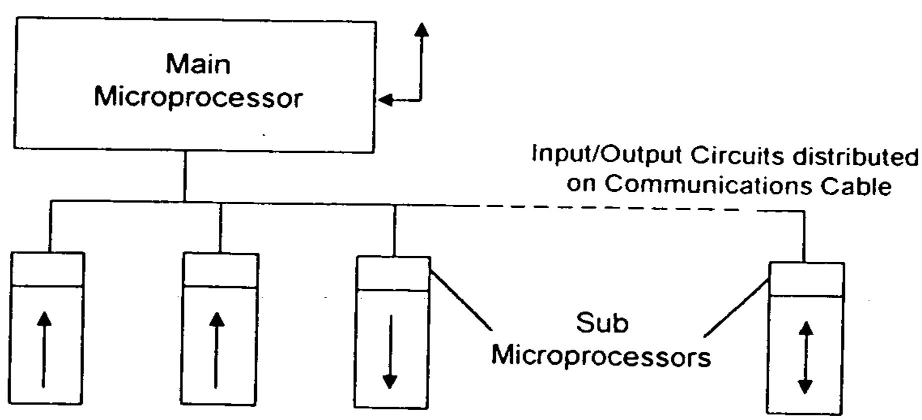


Fig. 1c

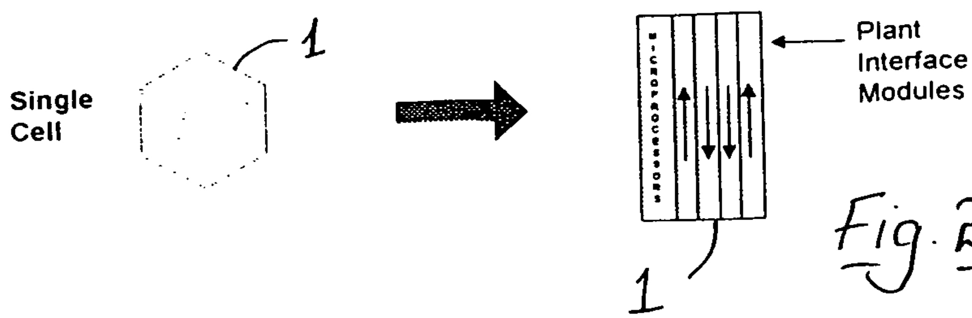


Fig. 2a

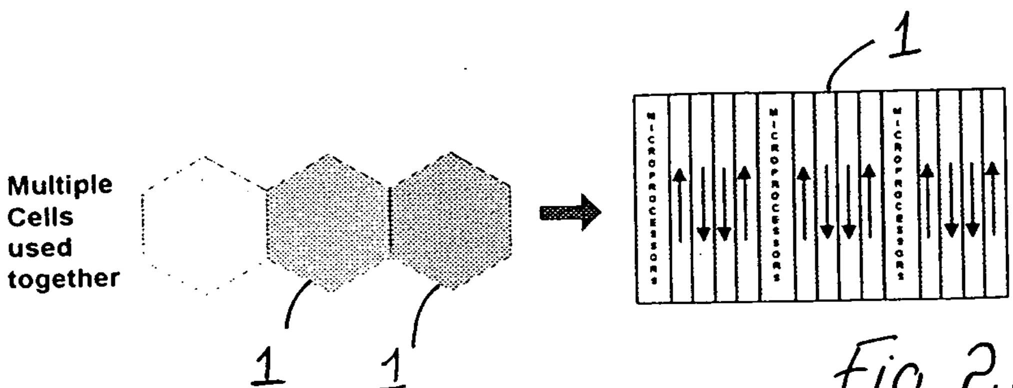


Fig. 2b

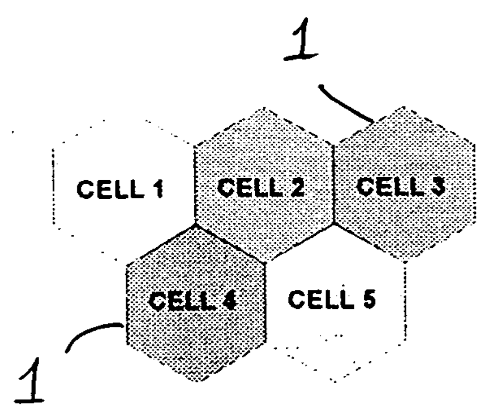


Fig. 3

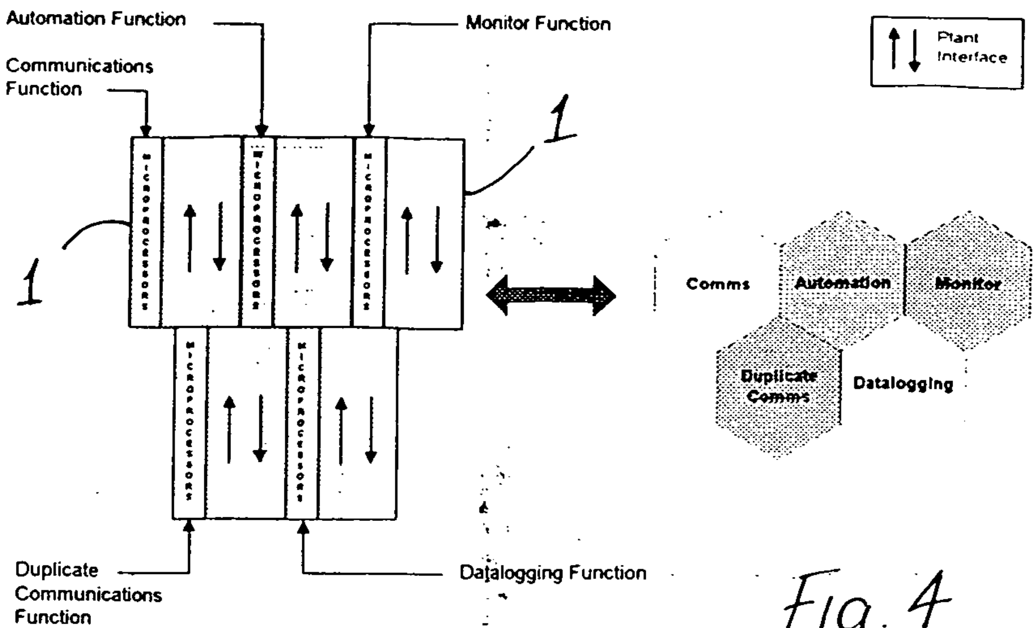
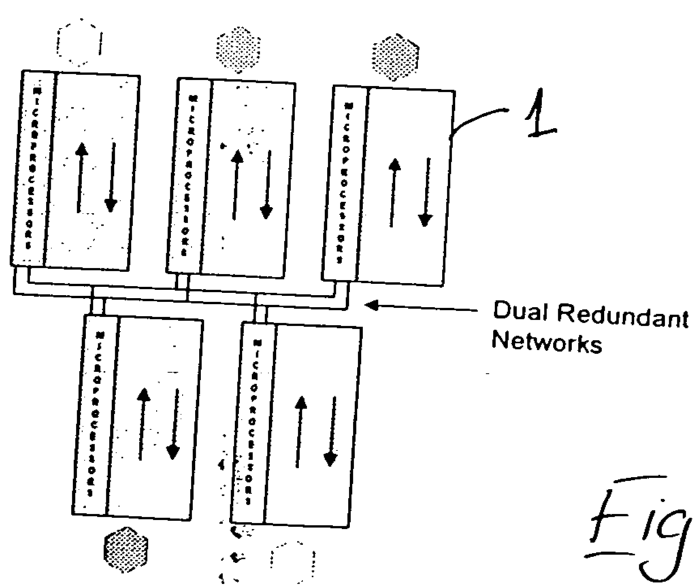

Automation Function
Monitor Function
Communications Function
Plant Interface
1
1
Comms
Automation
Monitor
Duplicate Comms
Datalogging
Duplicate Communications Function
Datalogging Function

Fig. 4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Dual Redundant Networks

Fig. 5